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(54) Liquid bath suction cleaner with rotating separator

(57) Liquid-assisted suction cleaner (10) with a separator (40) rotating at high speed, of a truncated-cone shaped structure formed of a number of radial helical vanes (41), slightly concave externally, whose width and thickness decrease from a thick ring (50), forming the greater base (47), to the smaller base (48) with a flat bottom (51), said vanes being held firm by an internal ring (49), said separator being preferably constructed in one single piece of plastic material, balanced by adjustment, in the die used to mould it, of the depth of cavities (56, 57) made in the thick ring (50) and in the bottom (51), a coat of epoxy paint being applied inside and outside to prevent formation of humid areas that would lead to variations in dimensions that in turn would be the cause of vibrations.

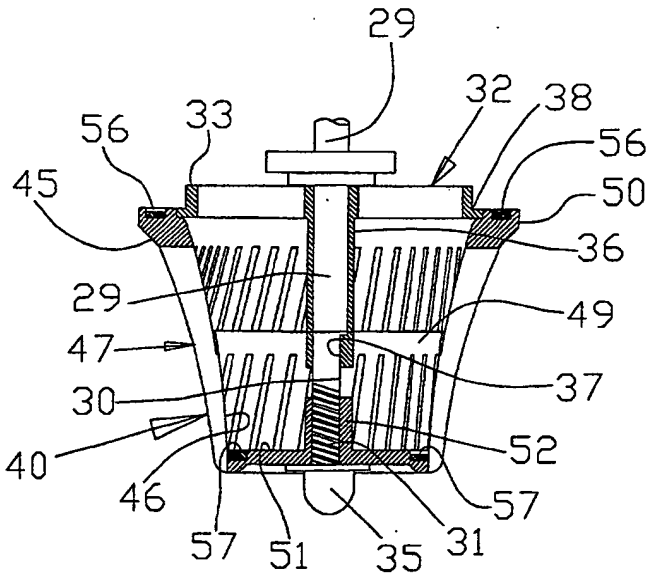

FIG.9

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Description

[0001] The invention concerns liquid-assisted suction cleaners with a rotating separator.

[0002] In this type of suction cleaner, as is generally known, the air drawn in for cleaning is forced into contact with a liquid, generally water, that captures the particles of dust and dirt, the advantage being that, in the absence of a filter, all that is needed is a periodical change of water.

[0003] It is also known that a specific device, called a separator, is used to project the air against the liquid and at the same time free it of the particles of dirt it contains.

[0004] The shape of the separator is cylindrical or conical; in its side walls are a number of slits through which the air is drawn in.

[0005] To obtain reliable operation of the appliance, there must be a fairly large number of slits, or else the separator will have to rotate at high speed so that, in the unit of time, a sufficient number of slits will be available for use in sequence to drive the air onto the liquid where the particles of dirt are separated out, and at the same time clean air be sucked in by a fan, provided for the purpose, through the slits and moved up to a grill in the top iof the suction cleaner.

[0006] It is therefore clear that the separator must necessarily be of a complex structure, but also that its dynamic characteristics must be precisely calculated to ensure reliable operation.

[0007] It is obviously desirable to have a relatively small type of separator so that the cleaner may be compact and its price reasonably low.

[0008] A problem however arises over resistance of the diaphragms between one slit and another, these diaphragms being vanes and the like which, by their very nature, must be long and thin.

[0009] Another and serious problem arises because the vanes tend to absorb humidity which alters their dimensions and weight.

[0010] Allowing for the fact that the separator turns at a high speed, performance may consequently vary and, in particular, vibrations of a harmful kind may develop.

[0011] The invention here described overcomes most, or even all, of these drawbacks as will now be explained.

[0012] Subject of the invention is a liquid-assisted suction cleaner with an electric motor operating at high speed.

[0013] The separator presents a truncated-cone shaped structure formed of a number of radial vanes of a substantially rectanguler cross section, widths and thicknesses decreasing from the greater base, facing towards the electric motor, to the smaller base.

[0014] The vanes are slightly helical.

[0015] Because of their helical shape, their position, starting from the axis of the separator, leads to an angular orientation of their projecting ends, on a geometrical plane perpendicular to said axis of the separator, of about 24°.

[0016] Advantageously the vanes are joined together by an internal ring placed substantially halfway up their height, flush with their internal walls, and made with them to form a single piece.

[0017] In one advantageous type of execution dimensions of the main parts of the separator are substantially as follows.

[0018] Height and thickness of the ring: respectively mm 10 and mm 1.

[0019] Height of the vanes measured on the axis of the separator: mm 30.

[0020] Diameter of the greater base: mm 55.

[0021] Diameter of the smaller base: mm 41.

[0022] Width of the vanes at the greater base: mm 5.

[0023] Width of the vanes at the lesser base: mm 3.

[0024] Thickness of the vanes at the greater base: mm 3.2.

[0025] Thickness of the vanes at the smaller base: mm 1.9

[0026] The lesser sides of the radial vanes are preferably slightly arched, the radius of the external concavity being approximately mm 200.

[0027] The separator is preferably made in a single piece of moulded plastic material.

[0028] To compensate for any possibly uneven distribution of the mass of plastic material and to avoid vibrations due to rotation at high speed, the separator is balanced by the presence on its flat external face of a thick ring forming the separator's greater base, as well as by the presence, on the internal face of its flat bottom at the smaller base, of a number of closely-placed circumferential cavities, the depth of each of said cavities being adjusted by screwing up or unscrewing the projecting heads of screw parts present in the die, used for moulding the separator, in order to create said cavities.

[0029] The separator is preferably fixed to the shaft of the electric motor by a spacer comprising a circular base, with external ribbing, the dimensions of this base corresponding to a circular seat made on the internal wall of the thick ring forming the greater base of the separator.

[0030] In this spacer is a central tubular column, to be applied to the shaft of the electric motor, its end facing towards the smaller base of the separator and matching the outer edge of the circular base of the spacer, with a circular seat on the inner edge of said thick ring.

[0031] On the bottom of the separator, at its smaller base, is a central tubular column that permits entry and exit of the threaded end of the shaft of the electric motor through a central hole made for the purpose in said bottom of the separator.

[0032] By screwing a threaded head onto said threaded end, the separator is locked on the drive shaft both at the greater base by means of the spacer, and at the smaller base, to provide maximum protection against vibrations that could be generated when the separator rotates at high speed.

[0033] The separator is caused to rotate by a longitudinal flat area present at the end of the drive shaft onto which can be fitted both a flat raised area, made at the top of the tubular column of the spacer, as well as a raised area on the inside, and over the whole length, of the hole in the tubular column made in the bottom that forms the smaller base of the separator.

[0034] The separator is painted with epoxy paint to protect it from the water and to prevent the formation of damp , especially on the surfaces of the vanes, such as would alter both dimensions and weight, with consequent variations in performance and generation of vibrations.

[0035] The disclosure offers evident advantages,

[0036] A smaller seperator and greater speed of rotation but avoiding the vibrations that such speed generally produces, provide all the advantages that a reduced size can offer without the negative effects.

[0037] This means that, while maintaining an optimum level of performance, it becomes possible to achieve a considerable reduction in size, weight and bulk of the cleaner.

[0038] Elimination of vibrations in the separator in spite of high speed is made possible by a number of synergetically acting factors, listed here below, chiefly concerning the characteristics of the vanes between one slit and another:

- application of epoxy paint to the separator and especially to the vanes
- progressive reduction in vane size from the greater to the lesser base of the separator
- helical configuration of the vanes
- slight external concavity of the vanes
- vane stability due to their being joined by the internal ring
- balancing by adjustment of depth of cavities both at the greater base of the separator and at its bottom near the smaller base
- stabilization of both the greater and smaller bases of the separator due respectively to presence of the circular base of the spacer with internal tubular column and of the internal tubular column fixed to the bottom of the separator.

[0039] Characteristics and purposes of the invention will be made still clearer by the following examples of its execution illustrated by diagrammatically drawn figures.

[0040] Fig. 1 Suction cleaner with electric motor and rotating separator, side view.

[0041] Fig. 2 As above showing a partial longitudinal section.

[0042] Fig. 3 An exploded view of the cleaner in Fig. 1.

[0043] Fig. 4 Spacer for optimum assembly of the separator on the shaft of the electric motor, longitudinal section.

[0044] Fig. 5 As above, plan view.

[0045] Fig. 6 Plan view of the separator, seen from outside.

[0046] Fig. 7 Longitudinal section of the separator at the centre line.

[0047] Fig. 8 Plan view of the inside of the separator.

[0048] Fig. 9 Detail of assembly of the separator, with the spacer, on the shaft of the electric motor.

[0049] The suction cleaner 10 comprises an upper cowling 11, handle 12, motor cover 13 with grill 14 for outflow of cleaned air, the container 16 with a lever clasp 17 to hold the container 16 to the cover 13.

[0050] Substantially at the top of the container 16 is an air entry mouth 21 connected to the bottom of the container 16 by an S-shaped immersion tube 22 at whose lower end is an outflow mouth at the end of a short curve.

[0051] The container stands on a trolley 18 with wheels 19.

[0052] The electric motor 25, surrounded by its chamber 26, rests on the motor-support 27 with a truncated-cone shaped lower body, and, by means of the shaft 29, works the fan 28.

[0053] The spacer 32 and separator 40, are fitted on the end of said shaft.

[0054] Their pulling action is assured by a flat area 30 made on said shaft 29 (Figure 9).

[0055] The spacer 32 (Figures 4 and 5) presents a circular annular base 33 with spokes 34 and external rim 38.

[0056] In the centre of the base is a tubular column 36 at the end of which is an internal flat prominence 37.

[0057] The separator 40 presents a truncated-cone shaped structure formed of a number of longitudinal helical vanes 41 that give rise to a number of substantially parallel slits, said structure having a greater base 47 and a smaller base 48 (Figure 6).

[0058] At the greater base 47 said vanes present a cross section 44 longer and wider than their cross section 43 at the smaller base.

[0059] The outer 45 and inner side 46 of each vane 41 are concave in shape roughly corresponding to an arc of a circle (Figure 7).

[0060] At about halfway up their height the vanes are connected internally to the separator by a ring 49, the purpose of this being to reduce vibrations in the separator that would otherwise be caused by its high speed of rotation.

[0061] At the greater base 47 there is a thick external ring 50, of a larger diameter, having an internal circular seat 60 whose dimensions correspond to those of the external rim 38 of the circular annular base 33 of the spacer 32.

[0062] The smaller base 48 is closed at the bottom 51.

[0063] Said ring 50 and said bottom 51 respectively present crowns 54 and 55 of small cylindrical cavities 56, 57, at the base of which are the heads of screws prepared in the die that moulds the separator in a single piece.

[0064] Therefore, by screwing and unscrewing the

screws in a certain way, the bottom of said cavities can be adjusted as desired to achieve perfect balance of weights so as to prevent or greatly reduce vibrations caused by the speed of rotation.

[0065] The separator is assembled as follows (Figure 9).

[0066] At the circular base 33 the tubular column 36 of the spacer 32 is fitted into the shaft 29 of the electric motor, this being done until the prominence 37 on said column makes contact with the cylindrical side of said drive shaft where the flat area 30 begins.

[0067] The separator is then mounted inserting the column 52 on the bottom 51 of said separator, at its smaller base 48, making the flat prominence 53 (Figure 7) on said column coincide with the flat area at the end 30 of the drive shaft (Figure 9), as far as entry of the rim 38 on the spacer 32 into the inner annular seat 60 of the annular edge 50 of the separator.

[0068] The threaded tip 31 of the drive shaft projects from said bottom 51 of the separator where the threaded head 35 can be screwed on.

[0069] For one type of execution the following approximate dimensions will be preferable (Figure 7).

[0070] At the position of the slits 42:

A the greater base of the separator: 55 mm
B the smaller base of the separator: 41 mm
C length of the separator: 30 mm
D external radius of curvature of the vanes: 200 mm
E internal radius of curature of the vanes: 200 mm

[0071] Cross section 44 of the vanes at the greater base (Figure 6):

F width: 5 mm
G thickness: 3.2 mm

[0072] Cross section 43 of the vanes at the smaller base:

H width: 3 mm
I thickness: 1.9 mm

[0073] Internal separator ring 49:

L height: 10 mm
M thickness: 1 mm
N Angle orientation, starting from the separator axis, of projection of the ends of vanes on a geometrical plane orthogonal to the axis of the separator: 24°.

[0074] As the figures show, on starting the motor, air from outside mixed with dust and dirt is drawn in by the fan 28, enters the container 16 through the mouth 21 and, through the S-shaped tube 22 passes ssubstantially to the bottom of the container 61 kept full of water.

[0075] The air, dust and water mixed together penetrate through the open bottom in the cylindrical chamber 23 that surrounds the separator 40, where the vanes in said separator thrust it against the walls of said chamber 23 in so doing separating the dust and dirt from the air and also from the water, as shown by the white arrows 62 (clean air) and by the black arrows (dust and dirt).

[0076] Whte arrows only may be seen inside the separator (Figure 2).

[0077] This action by the separator forms a downflowing column of dust and water which, from the chamber 23, passes on to become mixed with the water in the bottom of the container.

[0078] Through the separator the cleaned air reaches the top of the motor-support 27 and passes outside through the grill 14 on the motor cover 13.

[0079] The rotatingseparator is coated inside and outside with epoxy paint to protects it from the water and prevent formation of damp, especially on vane surfaces, that would cause variations in dimensions and weights compared with those originally designed, leading to an uneven performance and to generation of vibrations.

[0080] As the above invention has been described and explained solely as an example not limited to this, and to show its essential features, it is understood that numerous variations may be made to it in accordance with industrial, commercial and other requirements, and that other systems and means may be included in it without thereby causing a departure from its sphere of application.

[0081] It is therefore understood that a request to patent the invention comprises any equivalent use of the concepts and any equivalent product executed and/or in operation according to any one or more characteristics set forth in the following claims.

Claims

1. Liquid-assisted suction cleaner (10) with a rotating separator (40) and with a high-speed electric motor (25)
   characterized in that the separator (40) presents a truncated-cone shaped structure formed of a number of radial vanes (41) of a substantially rectangular cross section, of widths (F H) and thicknesses (G I) that decrease from the greater base (47) situated towards the electric motor (25), to the smaller base (48).

2. Liquid-assisted suction cleaner (10) with rotating separator (40) as in claim 1,
   characterized in that the vanes (41) are slightly helical.

3. Liquid-assisted suction cleaner (10) with rotating separator (40) as in claim 2,
   characterized in that, due to their helical shape, the position of the vanes (41) gives rise to an angu-

lar orientation (N), starting from the axis of the separator, to the projections of their ends on a geometrical plane orthogonal to said axis of the separator, of substantially 24°.

4. Liquid-assisted suction cleaner (10) with rotating separator (40) as in claim 1, **characterized by** the fact that the vanes (41) are fixed one to another by an internal connecting ring (49) placed substantially half way up the height of the vanes (41) flush with their internal wall (46) and constructed to form a single body with said vanes (41).

5. Liquid-assisted suction cleaner (10) with rotating separator (40) as in claim 4, **characterized in that** the dimensions of the ring (49) are substantially as follows: height (L) mm 10, thickness (M) mm 1.

6. Liquid-assisted suction cleaner (10) with rotating separator (40) as in claim 1, **characterized in that** the height (C) of the vanes (41), measured on the axis of the separator is substantially of mm 30.

7. Liquid-assisted suction cleaner (10) with rotating separator (40) as in claim 1, **characterized in that** the diameter (A) of the greater base (47) is substantially mm 55.

8. Liquid-assisted suction cleaner (10) with rotating separator (40) as in claim 1, **characterized in that** the diameter (B) of the smaller base 48 is substantially mm 41.

9. Liquid-assisted suction cleaner (10) with rotating separator (40) as in claim 1, **characterized in that** the width (F) of the vanes (41) at the greater base (47) is substantially mm 5.

10. Liquid-assisted suction cleaner (10) with rotating separator (40) as in claim 1, **characterized in that** the width (H) of the vanes (41) aat the smaller base (48) is substantially mm 3.

11. Liquid-assisted suction cleaner (10) with rotating separator (40) as in claim 1, **characterized in that** the thickness (G) of the vanes (41) at the greater base (47) is substantially mm 3.2.

12. Liquid-assisted suction cleaner (10) with rotating separator (40) as in claim 1, **characterized in that** the thickness (I) of the vanes (41) at the smaller base (48) is substantially mm 1.9.

13. Liquid-assisted suction cleaner (10) with rotating separator (40) as in claim 1, **characterized in that** externally the radial vanes (41) are slightly concave.

14. Liquid-assisted suction cleaner (10) with rotating separator (40) as in claim 13, **characterized in that** the radius (D) of concavity is substantially 200 mm.

15. Liquid-assisted suction cleaner (10) with rotating separator (40) as in claim 1, **characterized in that** the separator (40) is constructed of plastic material moulded in a single piece.

16. Liquid-assisted suction cleaner (10) with rotating separator (40) as in claims 1 and 15, **characterized in that** balancing of the separator (40), to compensate for any uneven distribution of the mass of plastic material and thus avoid vibrations caused by the high speed of rotation, is obtained by the presence on the external flat face of a thick ring forming the greater base (47) of the separator (40), a number of cavities (56) at a short distance one from another around a circumference (54) and adjusting the depth of each of said cavities (56) by tightening or unscrewing the projecting head of screw parts placed in the mould used to produce the separator (40), to form said cavities (56).

17. Liquid-assisted suction cleaner (10) with rotating separator (40) as in claim 1, **characterized in that** balancing of the separator (40) to compensate for any uneven distribution of the mass of plastic material and thus avoid vibrations caused by the high speed of rotation, is obtained by the presence on the internal face of the flat bottom (51) of the separator (40) at the position of the smaller base (48), of a number of cavities (57) placed at a short distance one from another around a circumference (55) at a short distance from the vanes (41) and adjusting the depth of each of said cavities (57) by tightening or unscrewing the projecting head of screw parts placed in the mould used to produce the separator (40) to form said cavities (51).

18. Liquid-assisted suction clelaner (10) with rotating separator (40) as in claims 1 and 16, **characterized in that** the separator (40) is fixed to the shaft (29) of the electric motor (25) by means of a spacer (32) comprising a circular base (33) with an external rim (38) of dimensions corresponding to those of a circular seat (60) made on the internal rim of the thick ring (50) constituting the greater base (47) of the separator (40), said spacer (32) being provided with a central tubular column (36) for application to the shaft (29) of the electric motor (25)

with its end facing towards the smaller base (48) of said separator (40) till the external rim (38) of the circular annular base (33) of the spacer (32) matches with the circular seat (60) on the internal rim of said thick ring (50), there being placed on the bottom of the separator (40) at the position of its smaller base (48) a central tubular column (52) that permits the threaded end (31) of the shaft (29) of the electric motor (25) to pass and emerge through the bottom (51) of the separator (40) and therefore permitting a threaded head (35) to be screwed onto said end (31) thus locking the separator (40) on the shaft (29) of the motor, both at the greater base (47) by means of the spacer (32) and at the smaller base (48), to achieve maximum protection against vibrations that could be generated by the high speed at which the separator (40) rotates.

19. Liquid-assisted suction cleaner (10) with rotating separator (40) as in claims 1 and 18, **characterized in that** rotation of the separator (40) is obtained by a longitudinal flat area (30) at the end of the shaft (29) of the motor, onto which fit both a flat prominence (37) made at the top of the tubular column (36) of the spacer (32) and also a prominence (53) made inside the hole, and along its entire length, in the tubular column (52) on the bottom (51) that forms the smaller base (48) of the separator (40).

20. Liquid-assisted suction cleaner (10) with rotating separator (40) as in claim 1, **characterized in that** the separator (40) and especially its vanes (41) are coated inside and outside with epoxy paint to form a screen against the water and prevent formation of humid areas such as would alter the dimensions and weights compared with those originally designed, with consequent variations in performance and generation of vibrations.

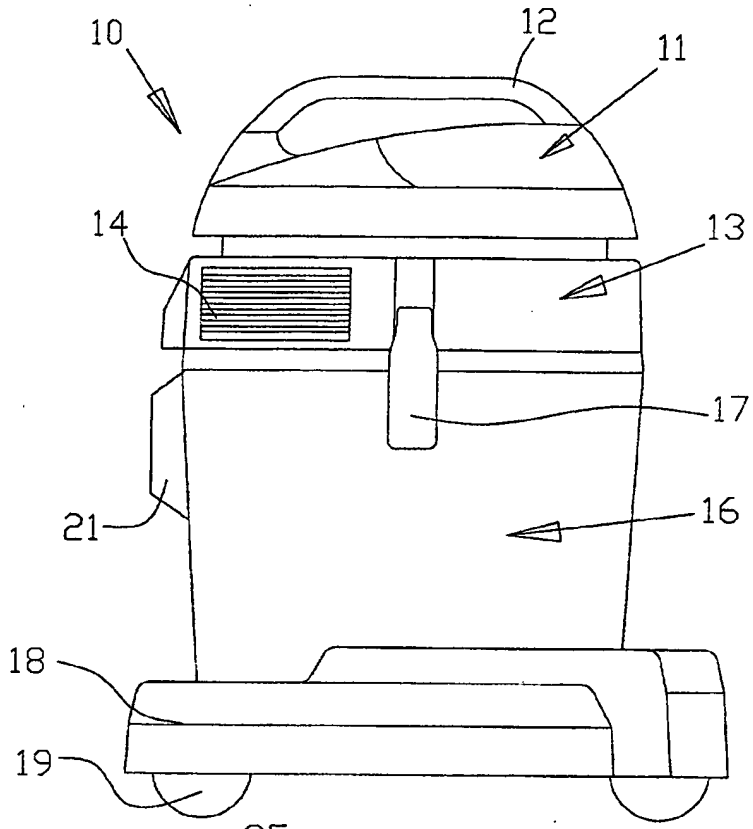

FIG.1

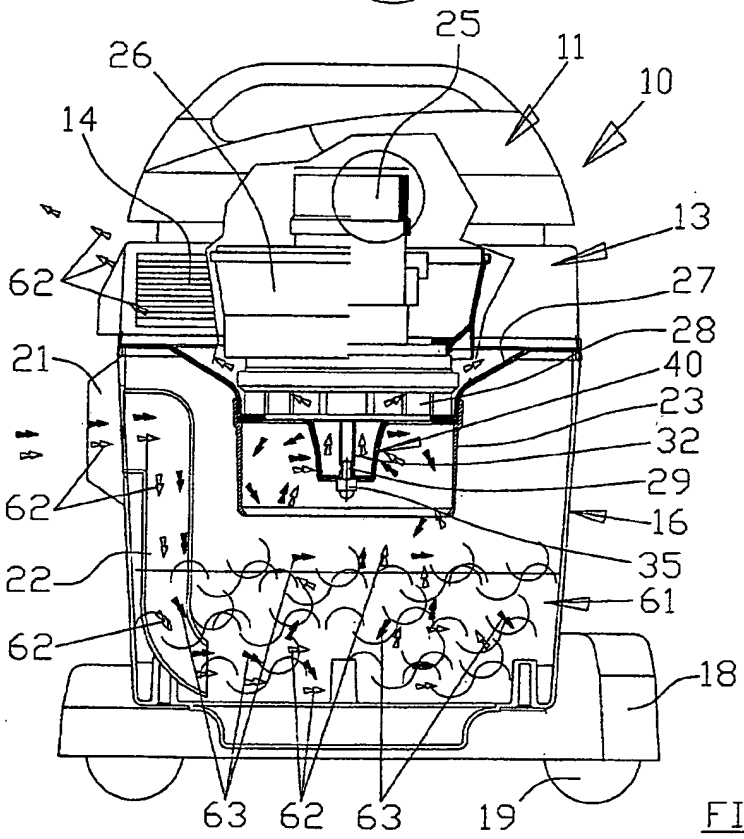

FIG.2

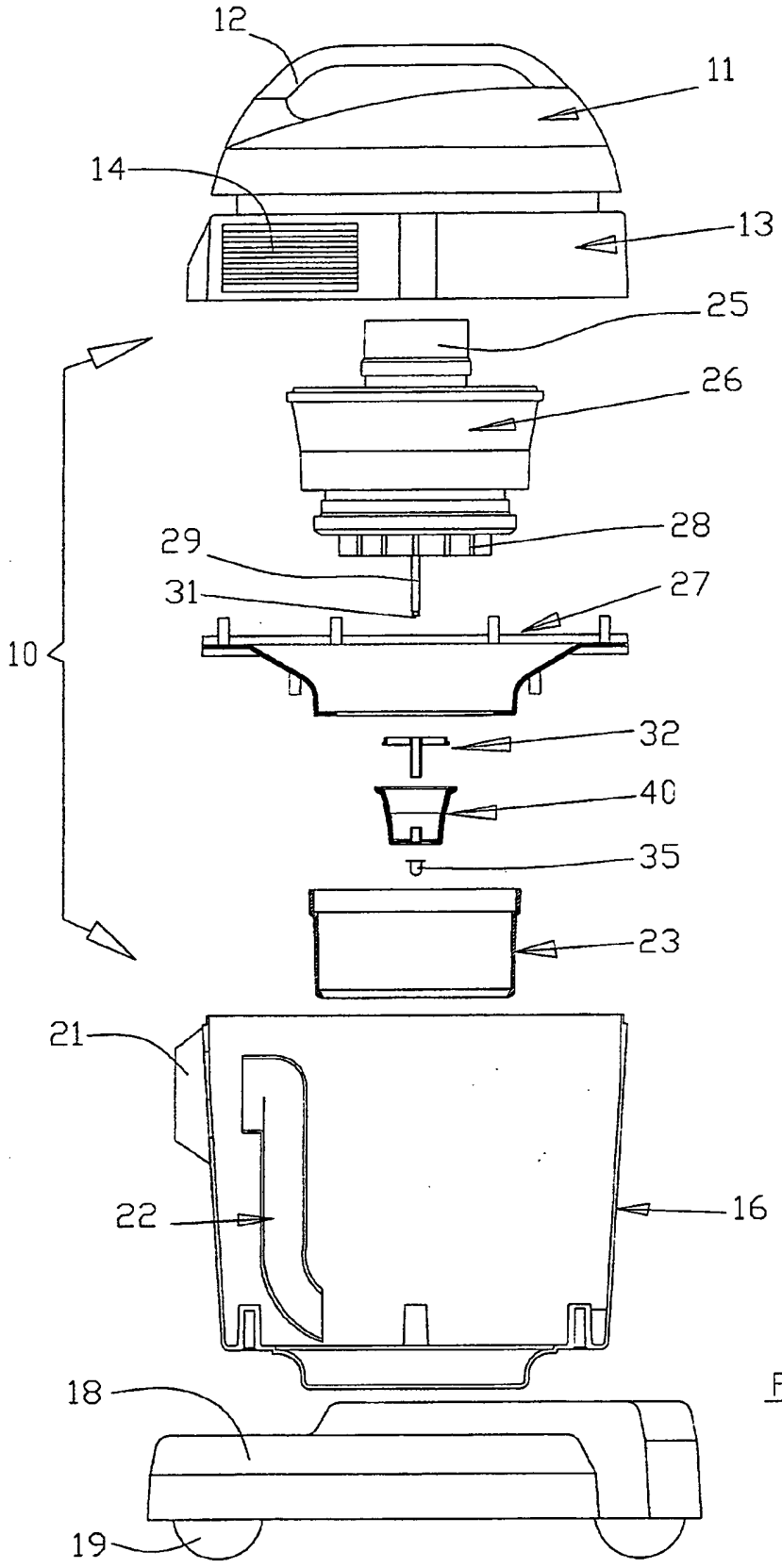

FIG.3

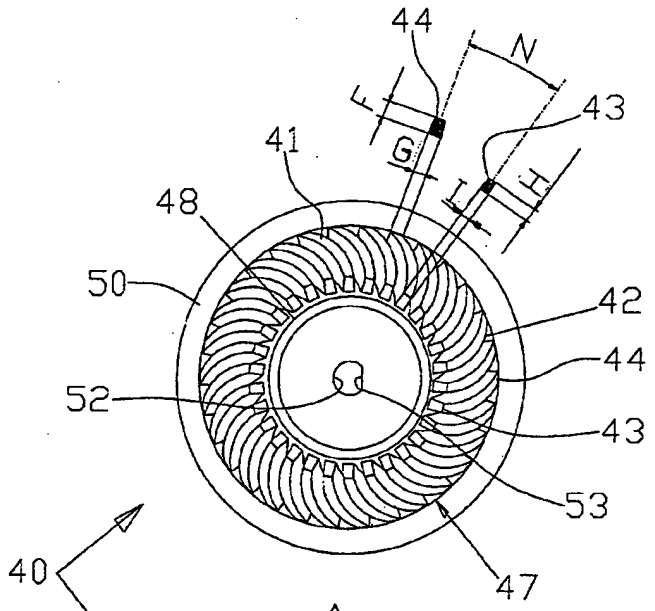

FIG.6

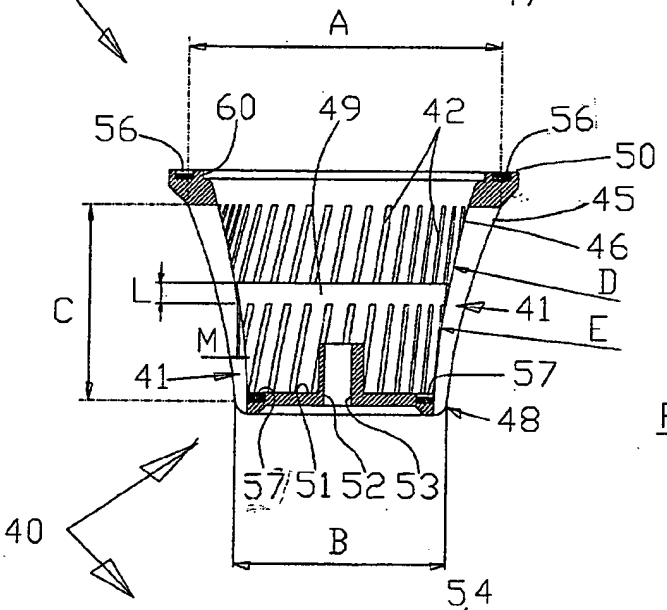

FIG.7

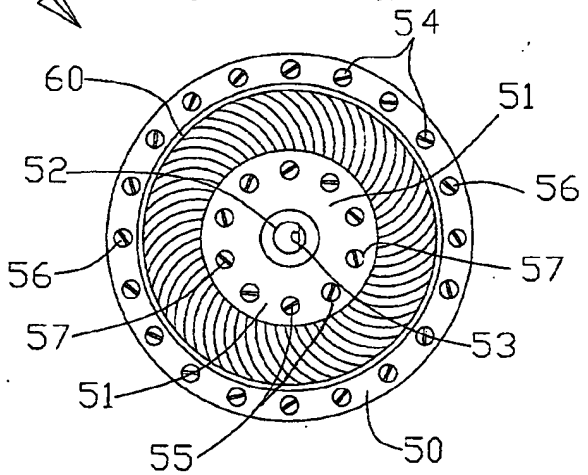

FIG.8

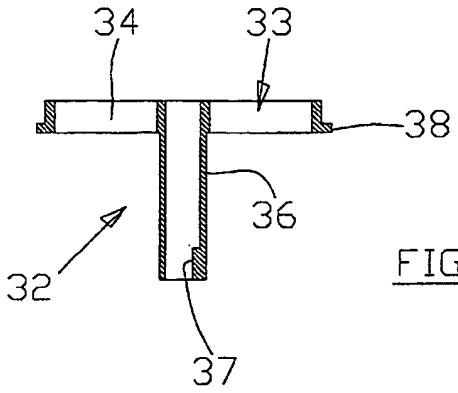

FIG.4

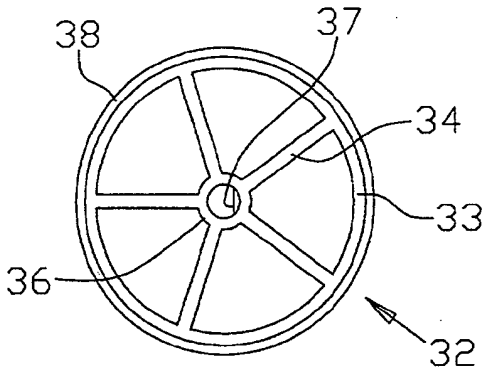

FIG.5

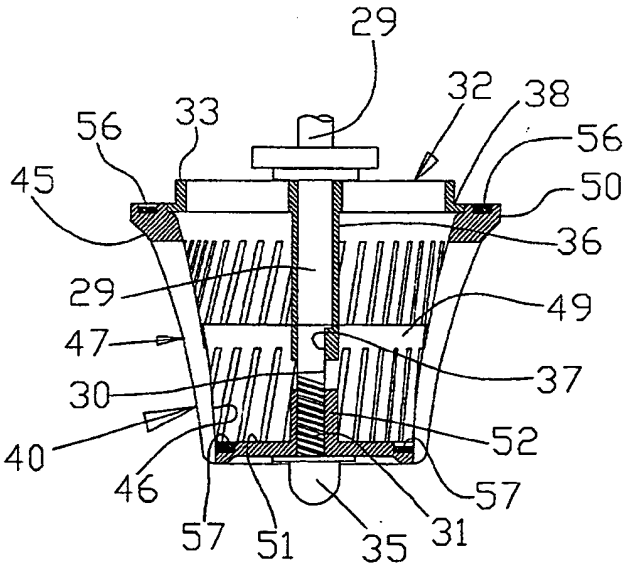

FIG.9

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